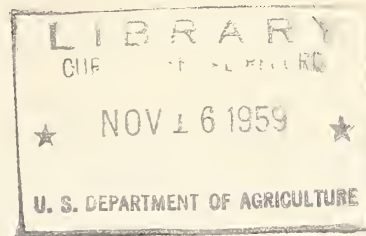


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# Cleaning CATTLE PENS on Terminal Stockyards



**METHODS and  
EQUIPMENT**

UNITED STATES DEPARTMENT OF AGRICULTURE  
Agricultural Marketing Service • Marketing Research Division  
Washington, D.C.

AMS - 345



## PREFACE

In an effort to find ways to reduce marketing costs, the Agricultural Marketing Service has made studies of many kinds of marketing facilities and equipment. In each case recommendations have been made for increasing efficiency. One field of study has covered terminal stockyards. In studies of stockyard operations, special analysis was needed to determine the most efficient methods of receiving, weighing, feeding livestock, and of cleaning the yards. Cleaning, which is the subject of this report, was deemed by market operators to be one of the most costly operations on terminal stockyards and one that offered great possibility for effecting savings.

Mechanical cleaning equipment of some type is used on practically all of the terminal stockyards. There is no equipment designed specifically for cleaning stockyards, so existing equipment has been adapted to this use.

This report provides data and guidelines on the relative efficiency of the different types of equipment used in cleaning cattle yards. It also provides data on the relative efficiency of the different combinations of types of equipment that may be used for various crew sizes and transport distances.

Greater efficiency in cleaning cattle pens probably could be obtained if the equipment used were specially designed for that purpose. However, sales potential for special equipment appears limited.

Acknowledgment is made to the stockyard operators who made their facilities available for study.

The study was conducted under the general supervision of George E. Turner, Marketing Research Analyst, Marketing Research Division, Agricultural Marketing Service.

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September 1959

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## SUMMARY

The front-wheel drive tractor with scoop plus the 3-wheel dump truck makes the lowest cost method for cleaning cattle yards at various transport distances and with different crew sizes.

The front-wheel drive tractor with scoop attached is more maneuverable and can fill a dump truck in less time than either the crawler-tractor or the rear-wheel drive tractor (also with scoops). The 3-wheel dump truck can transport a load of manure to the dump, dump it, and return to the cleaning area in less time than the 4-wheel dump truck. Based on a typical transport distance of 3,000 feet and a 4-man crew using 2 trucks, the cost per load for cleaning with the front-wheel drive tractor and 3-wheel dump truck is 42 percent less than with the crawler-tractor and 4-wheel dump truck, 40 percent less than with the crawler-tractor and 3-wheel dump truck, 23 percent less than with the rear-wheel drive tractor and 4-wheel dump truck, 2 percent less than with the rear-wheel drive tractor and 3-wheel dump truck, and 22 percent less than with the front-wheel drive tractor and 4-wheel dump truck.

Three operations are performed in cleaning cattle yards: (1) Scooping manure from yard floor and loading it onto a dump truck, (2) manually cleaning yard floor area under hay racks, water troughs, and in corners, and (3) transporting manure from cleaning area to manure dump. The efficiency with which each operation is performed depends primarily on the equipment used.

The elapsed time for scooping 7,000 pounds of manure from the yard floor and loading it onto a dump truck with a front-wheel drive tractor is 8.7 minutes, or 12 percent less than with a rear wheel drive tractor and 39 percent less than with a crawler-tractor.

The manual cleaning operation is paced by the scooping operation, and the elapsed time required for it is the same as that required for the scooping operation with various types of equipment.

The elapsed time for transporting manure to the dump is variable because the transport distances vary as cleaning moves to all parts of the yards. The elapsed time required for transporting 7,000 pounds of manure from the cleaning area to the dump, for a typical distance of 3,000 feet, with a 3-wheel dump truck is 10.2 minutes, or 23 percent less than that required with a 4-wheel dump truck. Less time is required with the 3-wheel dump truck because it makes right angle turns quicker, the driver can open gates without leaving his seat, and generally it is more maneuverable.

The optimum cleaning conditions for all methods is with a 4-man crew using 2 trucks and at a transport distance of 3,000 and 4,000 feet. Wait time is at a minimum under these conditions. This suggests that some stockyards might profitably relocate their manure dump.

It is estimated that the yards on which studies were made could average a reduction in their cleaning cost of about \$20,000 annually, or about 30 percent, by using the lowest cost method. Estimated cost reduction for individual yards ranged from 15 to 40 percent.



CLEANING CATTLE PENS ON TERMINAL STOCKYARDS--  
METHODS AND EQUIPMENT

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INTRODUCTION

In studies covering terminal stockyards, cleaning of the cattle pens was found to be one of the most costly operations and one that offered great possibilities for affecting savings.

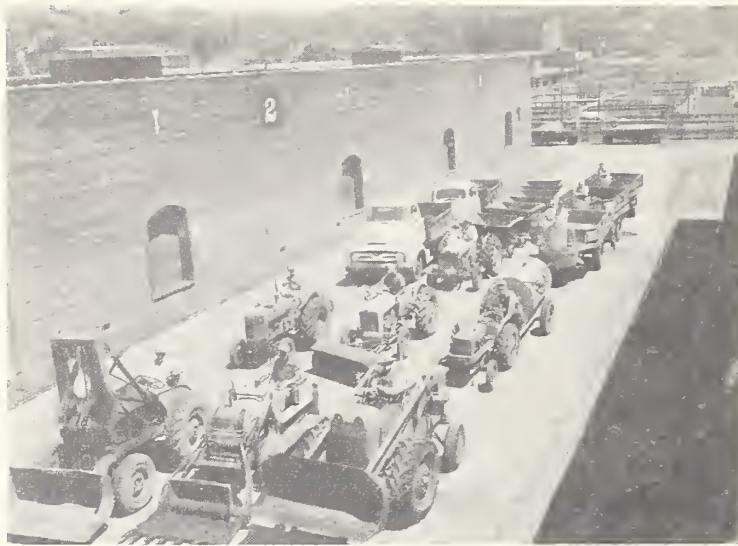
It is mandatory that yards be cleaned regularly to prevent the spread of diseases among animals brought to the market for sale, and to provide proper and reasonable services to market patrons and workers. Cleaning is a costly operation because of its high labor and equipment requirements. The investment in cleaning equipment on most yards is as great, if not greater, than that in any other stockyard operation.

Cleaning on terminal stockyards is divided into two parts, cleaning in the cattle yards and cleaning in the hog and sheep yards. The methods used for cleaning the cattle yards are different from those for the hog and sheep. Cattle yards require more labor and equipment. This report deals with cleaning the cattle division.

In many instances, the equipment used for cleaning is not standard among the different stockyards, and in some instances, is not standard within a particular stockyard (fig. 1). The object of this study is to measure the relative efficiency of certain work methods and equipment used by a limited number of stockyards in cleaning the cattle yards to provide a guide for performing the job more efficiently and with less cost.

Wage Rates Used in Computing Labor Costs

Workers used in cleaning have varying amounts of skill; consequently, their wage rates are different. The assumed hourly wage rate for a loader operator is \$2.00; a loader operator helper, \$1.80; and a truck driver, \$1.85.



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Figure 1.--Equipment used on a stockyard for cleaning pens and alleys.

### Equipment Costs

Data on equipment costs were obtained from equipment dealers. These costs are grouped into two major categories: (1) Ownership, and (2) operational. (Table 4 in appendix.)

Ownership costs include depreciation, taxes, interest, and insurance. All are considered to be fixed and are computed on an annual basis. Interest on the average investment is calculated at 5 percent, and 2 percent is allowed for insurance and taxes.

Operational costs include maintenance, repairs, inspection, servicing, and fuel oil. Total equipment cost is ownership cost plus operational cost. Per hour use cost is based on 1,500 hours of operation annually.

### Cost Comparisons for Cleaning

Labor and equipment costs for cleaning cattle yards are computed on a per truckload basis. A truckload of manure weighs about 7,000 pounds. The weight was determined by averaging the weights of truckloads of manure transported from cattle yards on four stockyards.

Labor and equipment costs per load are variable because transport distances differ. The amounts of equipment and labor used per truckload also change.

Labor cost for each operation consists of the total productive labor, plus the wait time, multiplied by an assumed wage rate. Equipment costs are based on the hours each item of equipment is used.

The cost comparisons do not include damages incurred by rough handling of mechanical equipment or resulting from use of unskilled labor. These costs are minor and difficult to evaluate.

### TYPES OF EQUIPMENT USED FOR CLEANING THE CATTLE YARDS

The equipment used in cleaning cattle yards falls into two general categories: (1) Mechanical loaders, and (2) dump trucks.

Each type of equipment has characteristics recommending its use. Frequently, cleaning equipment is used in several other operations. Multiple use is a factor of importance on some yards.

Mechanical loaders are used to clean manure from the floor of the pens and load it onto the dump trucks. A mechanical loader, as used in this report, is a tractor with a scoop (sometimes called dipper or bucket) attached.

There are many makes and models of tractors which can have a scoop attached and be used to load manure into a dump truck. There is no uniformity or standard as to design, size, or capacity of such tractors. In some instances, an improvised scoop, made by the maintenance crew, is attached to an existing tractor. The only criteria are a scoop size that does not eliminate completely the maneuverability of the tractor and a tractor powerful enough to handle the scoop with some degree of efficiency.

All of the mechanical loaders observed are of the general classification known as front-end loaders. However, three distinctly different loader types are in general use: (1) The crawler-tractor and scoop, (2) the rear-wheel drive tractor and scoop, and (3) the front-wheel drive tractor and scoop.

Dump trucks are used to transport manure from the cattle yards to the manure dump. The two types of dump trucks used are: (1) The 4-wheel dump truck, and (2) the 3-wheel dump truck.

#### Crawler-Tractor and Scoop

A crawler-tractor is a tractor mounted on endless plate metal treads with raised cleats for traction. The crawler-tractor has rubber shoes attached between each cleat to protect the pen floors and to reduce vibration and fatigue to the operator.

The crawler-tractors are the largest and heaviest of the three types observed in terminal stockyards. These tractors appear to be a little slower and somewhat less maneuverable than the other types. The models observed were larger and had more power than was necessary to do the job. A strong feature of this tractor is that it has excellent traction and performs very well on slopes.



The scoop attachment is actuated by hydraulic cylinders and associated mechanisms to raise, cant, lower, or otherwise maneuver the scoop. The bowl of the scoop attachment has a capacity of about 1,000 pounds of manure. The size of the scoop is from 4 to 5 feet wide and about 15 inches deep. To loosen the manure from the floor of the pens, the front edge of the scoop generally has teeth or prongs. These teeth are about 6 inches apart and are from 10 to 15 inches long.

### The Rear-Wheel Drive Tractor and Scoop

The rear-wheel drive tractor, for purposes of this report, is the common, four-wheel, rubber-tire tractor generally used on farms and ranches. The small steering wheels are in front, and the vehicle is powered from the rear axle (fig. 2). The rear-wheel drive tractor has a medium length wheel-base, with corresponding stability. It appears to have more maneuverability than the crawler type tractor; but, in some instances, it is too light for the work to be done. This was evidenced by lack of traction in the drive wheels and a tendency for the front wheels to leave the pen surface under heavy work conditions.

The scoop attachment used is the same as that described for the crawler-tractor.



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Figure 2.--A rear-wheel drive tractor with scoop attachment used to clean cattle pens.

### Front-Wheel Drive Tractor and Scoop

The front-wheel drive tractor is a four-wheel, rubber-tire vehicle with driving power in the front axle only. The front-wheel drive tractor (sometimes called a bucket wheel tractor because the powered axle is near the bucket or scoop) is compact, has a relatively short wheel base and small rear wheels with a short turning radius. The small rear wheels, capable of high degree turning, make this tractor highly maneuverable.

Most front-wheel drive tractors are equipped with power steering to reduce shock from bumps and to lessen driver fatigue. These tractors are capable of traveling up to 15 miles per hour, but under normal operating conditions in the cattle yards, they seldom travel faster than 6 to 8 miles per hour. The slower speeds are necessary owing to short transporting distances and the close quarters in pens and alleys.

The scoop attachment used is the same hydraulic mechanism previously described.

### Four-Wheel Dump Truck

The four-wheel dump truck has dual drive wheels in the rear and standard steering wheels in front. Most of those observed were of the snub-nosed variety.

The major problem in using the four-wheel dump truck is the difficulty of maneuvering in alleys and around corners.

### Three-Wheel Dump Truck

The three-wheel dump truck is powered from the rear axle and has two small steering wheels centered in the front somewhat similar to the centered front wheels of a four-row farm tractor (fig. 3). This truck has a shorter wheel base and a smaller turning radius than the four-wheel truck. It has considerably more maneuverability than the four-wheel truck. It has a bucket seat for the driver and no cab. The driver can open gates, when necessary, without leaving his vehicle, thereby speeding up the work.

## OPERATIONS PERFORMED IN CLEANING CATTLE YARDS

Cleaning cattle pens and alleys is generally done 5 days a week, Tuesday through Saturday. The work day normally is from 8 a.m. to 4 p.m. The number of workers and amount of equipment used varies widely from day to day and from market to market.

There is no established workload for cleaning. Bad weather and number of livestock affect the amount of cleaning work necessary. Several yards indicated that, as a rough rule of thumb, an attempt should be made to go over the cattle division about every 2 weeks. In general, the areas to be



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Figure 3.--A so-called three-wheel dump truck  
used for transporting manure to dump.

cleaned each day are chosen in a manner to insure equal treatment to all agencies operating on the market.

Cleaning is primarily a day shift operation. A few markets cleaned some pens at night. Night cleaning can be done only in well-lighted areas. The possible damage to yard facilities from using mechanical cleaning equipment at night appears to eliminate large scale night cleaning operations.

The responsibility for cleaning varies from yard to yard. In some, the stockyard company is responsible for cleaning the entire cattle division, including the commission firm, the dealer, and the packer areas. Some stockyard companies have no responsibility for cleaning the dealer area. Each dealer is responsible for the cleaning in his assigned area. The individual dealer may use his own employees to clean the pens or he may contract the cleaning to an outsider. Frequently, different methods of cleaning are used. The results of the studies herein pertain only to cleaning work performed by stockyard companies.

Three major operations involved in cleaning cattle yards are:

(1) Scooping manure from the floor and loading it onto trucks, (2) manually cleaning the floor under hay racks, water troughs, and in corners, and (3) transporting manure to dump, and dumping. In some instances the manure is removed from the dump to another location. This operation is not considered in this study.

Sometimes cattle alleys of stockyards are swept periodically with sweepers; however, no studies were made of this operation.

The cleaning work gradually moves from one section of the yards to another; and, as a result, the transport distances for hauling manure



constantly change. Thus, the degree of efficiency with which yards are cleaned depends not only upon how each major operation is performed, but also upon how the three operations are coordinated.

Each of the three major operations is discussed separately on the basis of equipment types used.

#### Scooping Manure from Yard Floor

Manure is scooped from the yard floor with: (1) A crawler-tractor and scoop, (2) a rear-wheel drive tractor and scoop, or (3) a front-wheel drive tractor and scoop. All three types of equipment perform alike. The equipment is operated by one worker (fig. 4). On an average the scoop picks up 1,000 pounds of manure at one time, and 7 scoops are required to fill a truck. Many factors, however, such as the quantity of manure on the floor, weather conditions, and pen sizes affect the sizes of the load picked up by the scoop at one time and also the elapsed time required to load a truck.

The elapsed time required for cleaning 7,000 pounds of manure from the yard floor and dumping it onto a truck with the crawler-tractor and scoop is 14.3 minutes (fig. 5). This is compared with 9.9 minutes for the rear-wheel



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Figure 4.--A front-wheel drive tractor with scoop attachment used to scoop manure from cattle pen floors.



BN-8829

Figure 5.--Dumping manure into a truck with a crawler-tractor and scoop.

drive tractor and 8.7 minutes for the front-wheel drive tractor. The difference in the time requirements is caused by the difference in the maneuverability of the machines. The crawler-tractor is less maneuverable than either of the other two machines. The crawler-tractor has a higher labor and equipment cost than either the rear-wheel drive tractor or the front-wheel drive tractor (table 1).

The cost for cleaning 7,000 pounds of manure from the yard floor and dumping it onto a truck by the crawler-tractor is \$1.34, which is more than twice the cost for the rear-wheel drive tractor, and about 2.5 times the cost for the front-wheel drive tractor. The total cost per load for each type of equipment could be different in cleaning manure from the yards because the transport time may affect the total time the equipment is used and also the total amount of labor required.

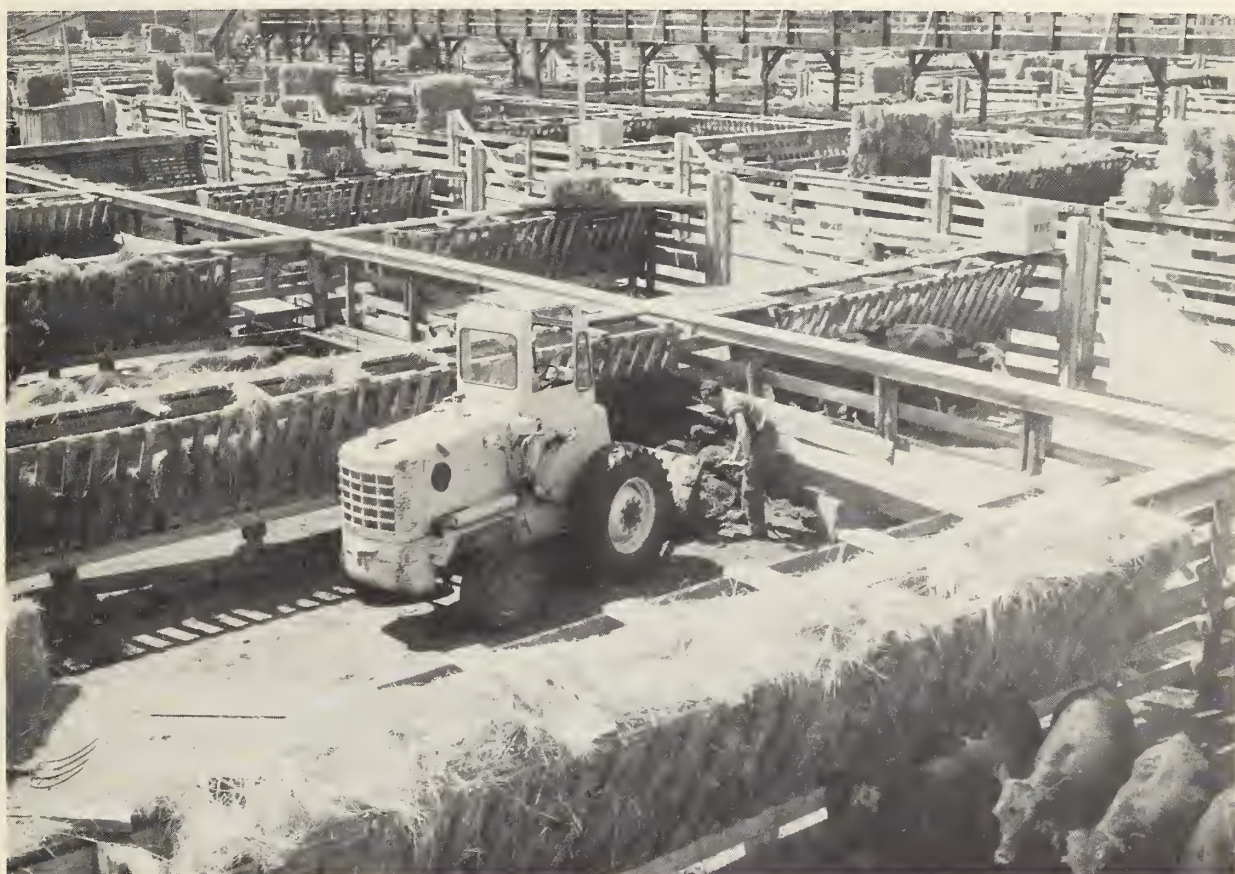
#### Manually Cleaning the Yard Floor

Manually cleaning the yard floor involves cleaning under hay racks, water troughs, and in corners of pens (fig. 6). The scoop is unable to reach



Table 1.--Labor and equipment requirements and costs for cleaning 7,000 pounds of manure from yard floor and dumping it onto a truck, with three different types of equipment, with one worker

| Equipment types                                  | : Elapsed :<br>: time : | Labor and equipment costs |           |         |
|--------------------------------------------------|-------------------------|---------------------------|-----------|---------|
|                                                  |                         | Labor                     | Equipment | Total   |
|                                                  | : Minutes:              | Dollars                   | Dollars   | Dollars |
| Crawler-tractor and scoop. . . . .               | 14.3                    | 0.48                      | 0.86      | 1.34    |
| Rear-wheel drive tractor and<br>scoop . . . . .  | 9.9                     | .33                       | .30       | .63     |
| Front-wheel drive tractor and<br>scoop . . . . . | 8.7                     | .29                       | .27       | .56     |



BN-8826

Figure 6.--A worker manually cleaning a cattle pen using a pitch fork.

these areas. Two workers using pitchforks, shovels, and rakes perform the operation. They usually begin their work at the same time the loader operator begins scooping manure from the yard floor. The two workers rake manure to a spot in the pen where the scoop can reach it. The last scoop of manure from a pen is partly filled by these two workers, because the pile has become so small that the scoop cannot effectively pick it up. There is no established workload for these workers, and the amount of manure they move is extremely variable. Usually, however, they are engaged in productive work as long as the scoop is operating. Therefore, the pace for the two workers is established by the pace of the machine.

The labor cost for manually cleaning the yard floor when paced by the three different types of equipment used is shown in table 2. The labor cost per 7,000-pound load when paced by the crawler-tractor is 30 percent higher than when paced by the rear-wheel drive tractor, and 38 percent higher than when paced by the front-wheel drive tractor. The total labor cost per load could be different because the transport time may affect the total amount of labor required.

Table 2.--Labor requirements for manually cleaning under water troughs, hay racks, and in pen corners, when paced by different types of equipment used in loading 7,000 pounds of manure on trucks with a 2-man crew

| Equipment used                        | : Elapsed        | : Labor              | : Labor          |
|---------------------------------------|------------------|----------------------|------------------|
|                                       | : time           | : production         | : cost           |
|                                       | : <u>Minutes</u> | : <u>Man-minutes</u> | : <u>Dollars</u> |
| Crawler-tractor and scoop . . . . .   | : 14.3           | : 28.6               | : 0.86           |
| Rear-wheel drive tractor and scoop. . | : 9.9            | : 19.8               | : .60            |
| Front-wheel drive tractor and scoop . | : 8.7            | : 17.4               | : .53            |

### Transporting Manure to Dump

Transporting manure to dump includes transporting manure from cleaning area to the dump, dumping it, and returning to the area (fig. 7). One worker does it, using either a 4-wheel or a 3-wheel dump truck. The operation is the same, regardless of type of truck. The capacity of the trucks is roughly 4 cubic yards.

The distance between the cleaning area and the dump is variable because cleaning gradually moves to all parts of the yards. In yards studied the distances ranged from 1,000 to 9,000 feet (round trip). Frequently, 2 or 3 trucks are used, particularly when the distance is 3,000 feet or more.

The elapsed time required for a worker to drive either type of truck from the cleaning area to the dump, dump the load, and return to the cleaning area is affected by the maneuverability of the truck, the number of closed





BN-8823

Figure 7.--A worker dumping a truckload of manure.

gates blocking his route, and the number of corners to be turned. The distances are standardized to make possible comparisons of the two types of trucks.

Table 3 shows the labor and equipment requirements and cost for transporting 7,000 pounds of manure to dump, dumping, and returning to cleaning area, by type of truck, and transport distances, with one worker. Less time is required to transport manure for all distances when the 3-wheel truck is used. Labor and equipment costs also are less. The 3-wheel truck is more maneuverable than the 4-wheel truck; it can make right angle turns quicker. Rarely is backing necessary, and the design permits the driver to open gates without leaving his seat.

The transporting cost per load in cleaning the yards is dependent on such factors as the number of trucks used, and the amount of wait time incurred.

Table 3.--Labor and equipment requirements and costs for transporting 7,000 pounds of manure to dump, dumping, and returning to cleaning area, by type of truck and transport distances, with one worker

| Transport distance | Four-wheel dump truck |                          |           |           | Three-wheel dump truck |                          |           |           |
|--------------------|-----------------------|--------------------------|-----------|-----------|------------------------|--------------------------|-----------|-----------|
|                    | Elapsed time          | Labor and equipment cost |           |           | Elapsed time           | Labor and equipment cost |           |           |
|                    | : Minutes             | : Dollars                | : Dollars | : Dollars | : Minutes              | : Dollars                | : Dollars | : Dollars |
| 1,000...           | 4.4                   | 0.14                     | 0.07      | 0.21      | 3.4                    | 0.10                     | 0.05      | 0.15      |
| 2,000...           | 8.8                   | .28                      | .14       | .42       | 6.8                    | .20                      | .10       | .30       |
| 3,000...           | 13.2                  | .42                      | .21       | .63       | 10.2                   | .30                      | .15       | .45       |
| 4,000...           | 17.6                  | .56                      | .28       | .84       | 13.6                   | .40                      | .20       | .60       |
| 5,000...           | 22.0                  | .70                      | .35       | 1.05      | 17.0                   | .50                      | .25       | .75       |
| 6,000...           | 26.4                  | .84                      | .42       | 1.26      | 20.4                   | .60                      | .30       | .90       |
| 7,000...           | 30.8                  | .98                      | .49       | 1.47      | 23.8                   | .70                      | .35       | 1.05      |
| 8,000...           | 35.2                  | 1.12                     | .56       | 1.68      | 27.2                   | .80                      | .40       | 1.20      |
| 9,000...           | 39.6                  | 1.26                     | .63       | 1.89      | 30.6                   | .90                      | .45       | 1.35      |

#### METHODS USED IN CLEANING CATTLE YARDS

The equipment types used in performing each operation are combined to provide six different methods that may be used in cleaning cattle yards: (1) Crawler-tractor, scoop, and 4-wheel dump truck; (2) crawler-tractor, scoop, and 3-wheel dump truck; (3) rear-wheel drive tractor, scoop, and 4-wheel dump truck; (4) rear-wheel drive tractor, scoop, and 3-wheel dump truck; (5) front-wheel drive tractor and 4-wheel dump truck; and (6) front-wheel drive tractor and 3-wheel dump truck method. The cattle yards may be cleaned by each method with a 3-man crew using 1 truck, a 4-man crew using 2 trucks, or a 5-man crew using 3 trucks.

When cleaning is done with a 3-man crew using 1 truck, 1 worker operates the loader and 2 workers manually clean the yard floor. When the truck is filled with manure, one of the workers who manually cleans, drives the truck-load of manure to the dump, dumps it, and returns. With a 4-man crew using 2 trucks, one worker operates the loader, 2 workers manually clean, and 1 worker drives the truck. One truck is being loaded while the other is enroute to and from the dump. With a 5-man crew using 3 trucks, 1 worker operates the loader, 2 workers clean manually and 2 workers drive trucks. One truck is usually being filled, while the other two are transporting manure to the dump.

Generally, the efficiency with which cleaning is performed by any of the six methods depends on how effectively the loading and transporting operations can be coordinated. Since the cleaning work gradually moves from point to point in the yards and transport distances are constantly changing perfect coordination is impossible for any extended period of time. Consequently, wait time is an inherent characteristic of the cleaning operation. In computing total labor and equipment requirements and costs by the various methods, this wait time will change the requirements and costs previously shown for individual operations. Furthermore, when cleaning is done with a 3-man crew using one truck, no coordination can be expected.



A 3-man crew using one truck seldom transports manure more than 3,000 feet. In most instances, for distances over 6,000 feet, a 5-man crew using 3 trucks is used. Therefore labor and equipment are computed at 1,000-foot distances up to 3,000 feet for the 3-man crew, 6,000 feet for the 4-man crew, and 3,000 to 9,000 feet for the 5-man crew.

A comparison of labor and equipment costs by methods, crew sizes, and transport distances is shown in table 5 of the appendix.

#### Crawler-Tractor, Scoop, and Four-Wheel Dump Truck Method

Table 6 in the appendix shows the labor and equipment requirements and costs for cleaning 7,000 pounds of manure from the cattle yards by the crawler-tractor and 4-wheel dump truck method, by transport distances and crew sizes.

In cleaning the cattle yards by this method the productive time and labor required for scooping manure from yard floor and dumping it onto the truck is the same for a 3-man crew using 1 truck, a 4-man crew using 2 trucks, and a 5-man crew using 3 trucks. The total time and labor varies with the size of the crew and number of trucks used. When a 3-man crew is used, the loader must wait while the driver takes the load to the dump, dumps it, and returns. The length of the wait time is in direct proportion to the time required to transport the manure to the dump, dump it, and return. The same amount of wait time is incurred in the manual cleaning operation.

When the yards are cleaned by the crawler-tractor, scoop, and 4-wheel dump truck method with a 4-man crew using 2 trucks, no wait time is incurred in the scooping or manual cleaning operations when transport distances do not exceed 3,000 feet. However, wait time is incurred in the transporting operation. Wait time is incurred in both the scooping and manual cleaning operation when the transport distance is between 4,000 and 6,000 feet. However, no wait time is incurred in the transport operation.

A similar situation occurs when a 5-man crew using 3 trucks is used. However, the wait times in the three operations occur at different transport distances.

The total cost per 7,000-pound load of manure varies with transport distances and with various crew sizes. Total cost per load with a 3-man crew using 1 truck ranges from \$3.16 for a transport distance of 1,000 feet to \$4.64 for a transport distance of 3,000 feet. Total cost per load with a 4-man crew using 2 trucks varies from \$3.07 per load for a transport distance of 1,000 feet to \$5.30 for a transport distance of 6,000 feet. Total cost per load with a 5-man crew using 3 trucks varies from \$3.72 for a transport distance of 3,000 feet to \$5.04 for a transport distance of 9,000 feet.

#### Crawler-Tractor, Scoop, and Three-Wheel Dump Truck Method

Table 7 in the appendix shows the labor and equipment requirements and cost for cleaning 7,000 pounds of manure from the cattle yards by the crawler-tractor, scoop and 3-wheel dump truck method, by transport distances and crew sizes.



The relationship between the three operations--scooping manure from the yard floor and dumping it onto trucks, manually cleaning yard floor area under hay racks, water troughs, and in corners, and transporting manure from cleaning area to the dump, dumping, and return, when cleaning is done by the crawler-tractor, scoop, and 3-wheel dump truck method, is similar to that described for cleaning by the crawler-tractor, scoop and 4-wheel dump truck method. The major difference between the two methods is that the 3-wheel dump truck transports the manure to the dump in less time than that required by the 4-wheel dump truck. As a result, the transport requirements and the wait time incurred in the scooping and manual cleaning operations also are less. Consequently, the cleaning cost per 7,000-pound load of manure is less by the crawler-tractor, scoop, and 3-wheel dump truck method.

The total cost per 7,000-pound load for cleaning the cattle yards by the crawler-tractor, scoop, and 3-wheel dump truck method varies from \$2.95 to \$4.09 for transport distances ranging from 1,000 to 3,000 feet for a 3-man crew using one truck, \$3.01 to \$4.11 for transport distances ranging from 1,000 to 6,000 feet for a 4-man crew using 2 trucks, and from \$3.62 to \$3.86 for transport distances ranging from 3,000 to 9,000 feet for a 5-man crew using 3 trucks.

#### Rear-Wheel Drive Tractor, Scoop, and Four-Wheel Dump Truck Method

The rear-wheel drive tractor and scoop loads 7,000 pounds of manure onto a dump truck in 31 percent less time than that required by the crawler-tractor. Consequently, less labor is required for cleaning cattle yards when the rear-wheel drive tractor is used. Table 8 in the appendix shows the labor and equipment requirements and costs for cleaning 7,000 pounds of manure from the cattle yards by the rear-wheel drive tractor and 4-wheel dump truck method, by transport distances and crew sizes.

The total cost per 7,000-pound load of manure cleaned from the yards varies widely by transport distances and by crew sizes. Total cost per load with a 3-man crew using one truck ranges from \$1.99 for a transport distance of 1,000 feet to \$3.20 for a transport distance of 3,000 feet. With a 4-man crew using 2 trucks the cost ranges from \$1.84 per load for a transport distance of 1,000 feet to \$4.36 for a transport distance of 6,000 feet. The cost varies with a 5-man crew using 3 trucks from \$2.29 for a transport distance of 3,000 feet to \$4.26 for a transport distance of 9,000 feet.

#### Rear-Wheel Drive Tractor, Scoop, and Three-Wheel Dump Truck Method

When the rear-wheel drive tractor and scoop is used with the 3-wheel dump truck to clean the cattle yards, labor and equipment requirements and cost are lower than when the four-wheel dump truck is used (table 9, appendix).

The total cost per 7,000 pounds of manure cleaned by the rear-wheel drive tractor, scoop, and 3-wheel dump truck method varies from \$1.81 per load for a transport distance of 1,000 feet with a 3-man crew using one truck to \$2.74 for

a transport distance of 3,000 feet. With a 4-man crew using 2 trucks the cost varies from \$1.79 for a transport distance of 1,000 feet to \$3.36 for a transport distance of 6,000 feet. With a 5-man crew using 3 trucks the cost ranges from \$2.22 per load for a transport distance of 3,000 feet to \$3.26 for a transport distance of 9,000 feet.

#### Front-Wheel Drive Tractor, Scoop, and Four-Wheel Dump Truck Method

The front-wheel drive tractor and scoop requires 12 percent less time to fill a truck with a 7,000-pound load of manure than the rear-wheel drive tractor and scoop, and 39 percent less time than the crawler-tractor. Table 10 in the appendix shows the labor and equipment requirements and cost for cleaning 7,000 pounds of manure from the cattle yards by the front-wheel drive tractor, scoop, and 4-wheel dump truck method, by transport distances and crew sizes.

The total cost per 7,000 pounds of manure cleaned from the yards with a 3-man crew using one truck ranges from \$1.84 per load for a transport distance of 1,000 feet to \$3.07 for a transport distance of 3,000 feet. With a 4-man crew using 2 trucks the cost ranges from \$1.62 for a transport distance of 1,000 feet to \$4.37 for a transport distance of 6,000 feet. The cost varies for a 5-man crew using 3 trucks from \$2.02 for a transport distance of 3,000 feet to \$4.25 for a transport distance of 9,000 feet.

#### Front-Wheel Drive Tractor, Scoop, and Three-Wheel Dump Truck Method

Table 11 in the appendix shows the labor and equipment requirements and cost for cleaning 7,000 pounds of manure from the cattle yards by the front-wheel drive tractor, scoop, and 3-wheel dump truck method, by transport distances and crew sizes.

With a 3-man crew using one truck the cost ranges from \$1.69 per load for a transport distance of 1,000 feet to \$2.60 for a transport distance of 3,000 feet. The cost with a 4-man crew using 2 trucks varies from \$1.58 for a transport distance of 1,000 feet to \$3.34 for a transport distance of 6,000 feet. With a 5-man crew using 3 trucks the cost ranges from \$1.96 for a transport distance of 3,000 feet to \$3.24 for a distance of 9,000 feet.

### POSSIBLE MARKET BENEFITS

The annual savings that could be realized by a particular terminal yard in cleaning cattle pens by adopting the front-wheel drive tractor, scoop, and 3-wheel dump truck method, the lowest cost cleaning method, would depend on such factors as the annual workload, transport distance to the manure dump, and the cleaning method now used. These factors vary widely from yard to yard.

Based on studies conducted in 4 terminal yards, it is estimated that these yards could reduce their cleaning cost an average of about \$20,000 annually

(\$10,230 in labor and \$9,770 in equipment), or 30 percent, by using the lowest cost method. Estimated cost reductions for individual yards ranged from 15 to 40 percent.

The cost of cleaning cattle pens by the lowest cost method is 42 percent less than the cost by the highest cost method. Thus yards with an annual cleaning workload of 5,000 to 8,000 loads might reduce their cleaning cost as much as \$10,000 per year (approximately \$4,400 in labor and \$5,600 in equipment); yards with an annual workload of 15,000 to 20,000 loads could reduce their cost as much as \$25,000 (\$11,000 in labor and \$14,000 in equipment); and the larger yards, handling up to 40,000 loads per year, could reduce cleaning cost as much as \$50,000 (\$22,000 in labor and \$28,000 in equipment).

As previously stated, none of the equipment types studied was specifically designed for cleaning cattle pens. It is possible that specially designed equipment could further reduce cleaning cost. However, sales potential for specially designed equipment for cleaning stockyards appears limited, and any immediate development of such equipment seems unlikely.

#### APPENDIX

In order to make comparisons between different types of equipment used for cleaning cattle yards, it was necessary to determine cost figures for each type of equipment included in the study. Table 4 shows the basis for the development of annual and per hour cost for each type of equipment.

Tables 5 through 11 show the labor and equipment requirements and costs per load for cleaning cattle yards using various equipment combinations, crew sizes, and transport distances.



Table 4.--Ownership and operating cost for equipment used in cleaning cattle yards

| Equipment                                   | Initial:<br>cost<br>1/ | Expected:<br>life<br>Years | Ownership cost |                   |                | Operating cost |                               |          | Total<br>annual<br>cost | Cost<br>per hour<br>of use<br>4/ |      |
|---------------------------------------------|------------------------|----------------------------|----------------|-------------------|----------------|----------------|-------------------------------|----------|-------------------------|----------------------------------|------|
|                                             |                        |                            | Dollars        | Depre-<br>ciation | Interest<br>2/ | Dollars        | Insurance:<br>and<br>taxes 3/ | Total    |                         |                                  | Fuel |
| Crawler-tractor and<br>scoop.....           | 14,000                 | 10                         | 1,400.00       | 350.00            | 280.00         | 2,030.00       | 2,250.00                      | 1,120.00 | 3,370.00                | 5,400.00                         | 3.60 |
| Rear-wheel drive<br>tractor and scoop.....  | 6,900                  | 10                         | 690.00         | 172.50            | 138.00         | 1,000.50       | 1,102.50                      | 552.00   | 1,654.50                | 2,655.00                         | 1.77 |
| Front-wheel drive<br>tractor and scoop..... | 7,400                  | 10                         | 740.00         | 185.00            | 148.00         | 1,073.00       | 1,102.50                      | 592.00   | 1,694.50                | 2,767.50                         | 1.85 |
| Four-wheel dump truck..                     | 4,300                  | 8                          | 537.50         | 107.50            | 86.00          | 731.00         | 206.25                        | 430.00   | 636.25                  | 1,367.25                         | .91  |
| Three-wheel dump truck..                    | 3,600                  | 8                          | 450.00         | 90.00             | 72.00          | 612.00         | 187.50                        | 360.00   | 547.50                  | 1,159.50                         | .77  |

1/ Based on f.o.b. factory prices.

2/ Interest at 5 percent of average investment.

3/ Insurance and taxes at 2 percent of initial investment.

4/ Based on 1,500 hours of use annually.



Table 6.--Labor requirements and costs for cleaning 7,000 pounds of manure from the cattle yards by the crawler-tractor and scoop and the four-wheel dump truck method, by transport distances and crew sizes 1/

| Transport distance           | Labor requirements by operations |       |            |       |                              |       |            |       |                             |       |            |       | Labor and equipment cost |       |                    |       |           |       |           |       |
|------------------------------|----------------------------------|-------|------------|-------|------------------------------|-------|------------|-------|-----------------------------|-------|------------|-------|--------------------------|-------|--------------------|-------|-----------|-------|-----------|-------|
|                              | Scooping manure from yard floor  |       |            |       | Manually cleaning yard floor |       |            |       | Transporting manure to dump |       |            |       | Equipment                |       | Labor              |       | Equipment |       |           |       |
|                              | Productive: time                 |       | Wait: time |       | Productive: time             |       | Wait: time |       | Productive: time            |       | Wait: time |       | Man- minutes             |       | Equipment: minutes |       | Labor     |       | Equipment |       |
|                              | 1,000                            | 2,000 | 3,000      | 4,000 | 1,000                        | 2,000 | 3,000      | 4,000 | 1,000                       | 2,000 | 3,000      | 4,000 | 1,000                    | 2,000 | 3,000              | 4,000 | 1,000     | 2,000 | 3,000     | 4,000 |
| Feet                         |                                  |       |            |       |                              |       |            |       |                             |       |            |       |                          |       |                    |       |           |       |           |       |
| 3-man crew using 1 truck 4/  | 14.3                             | 8.8   | 13.2       | 4.4   | 28.6                         | 28.6  | 8.8        | 13.2  | 4.4                         | 0     | 4.4        | 47.3  | 8.8                      | 56.1  | 37.4               | 1.76  | 1.40      | 3.16  |           |       |
| 1,000.....                   | 14.3                             | 8.8   | 13.2       | 4.4   | 28.6                         | 28.6  | 8.8        | 13.2  | 4.4                         | 0     | 4.4        | 51.7  | 17.6                     | 69.3  | 46.2               | 2.17  | 1.73      | 3.90  |           |       |
| 2,000.....                   | 14.3                             | 8.8   | 13.2       | 4.4   | 28.6                         | 28.6  | 8.8        | 13.2  | 4.4                         | 0     | 4.4        | 56.1  | 26.4                     | 82.5  | 55.0               | 2.59  | 2.05      | 4.64  |           |       |
| 3,000.....                   | 14.3                             | 8.8   | 13.2       | 4.4   | 28.6                         | 28.6  | 8.8        | 13.2  | 4.4                         | 0     | 4.4        | 47.3  | 8.8                      | 56.1  | 37.4               | 1.76  | 1.40      | 3.16  |           |       |
| 4-man crew using 2 trucks 5/ | 14.3                             | 8.8   | 13.2       | 4.4   | 28.6                         | 28.6  | 8.8        | 13.2  | 4.4                         | 0     | 4.4        | 51.7  | 17.6                     | 69.3  | 46.2               | 2.17  | 1.73      | 3.90  |           |       |
| 1,000.....                   | 14.3                             | 8.8   | 13.2       | 4.4   | 28.6                         | 28.6  | 8.8        | 13.2  | 4.4                         | 0     | 4.4        | 56.1  | 26.4                     | 82.5  | 55.0               | 2.59  | 2.05      | 4.64  |           |       |
| 2,000.....                   | 14.3                             | 8.8   | 13.2       | 4.4   | 28.6                         | 28.6  | 8.8        | 13.2  | 4.4                         | 0     | 4.4        | 47.3  | 8.8                      | 56.1  | 37.4               | 1.76  | 1.40      | 3.16  |           |       |
| 3,000.....                   | 14.3                             | 8.8   | 13.2       | 4.4   | 28.6                         | 28.6  | 8.8        | 13.2  | 4.4                         | 0     | 4.4        | 51.7  | 17.6                     | 69.3  | 46.2               | 2.17  | 1.73      | 3.90  |           |       |
| 4,000.....                   | 14.3                             | 8.8   | 13.2       | 4.4   | 28.6                         | 28.6  | 8.8        | 13.2  | 4.4                         | 0     | 4.4        | 56.1  | 26.4                     | 82.5  | 55.0               | 2.59  | 2.05      | 4.64  |           |       |
| 5,000.....                   | 14.3                             | 8.8   | 13.2       | 4.4   | 28.6                         | 28.6  | 8.8        | 13.2  | 4.4                         | 0     | 4.4        | 47.3  | 8.8                      | 56.1  | 37.4               | 1.76  | 1.40      | 3.16  |           |       |
| 6,000.....                   | 14.3                             | 8.8   | 13.2       | 4.4   | 28.6                         | 28.6  | 8.8        | 13.2  | 4.4                         | 0     | 4.4        | 51.7  | 17.6                     | 69.3  | 46.2               | 2.17  | 1.73      | 3.90  |           |       |
| 5-man crew using 3 trucks 6/ | 14.3                             | 8.8   | 13.2       | 4.4   | 28.6                         | 28.6  | 8.8        | 13.2  | 4.4                         | 0     | 4.4        | 56.1  | 26.4                     | 82.5  | 55.0               | 2.59  | 2.05      | 4.64  |           |       |
| 3,000.....                   | 14.3                             | 8.8   | 13.2       | 4.4   | 28.6                         | 28.6  | 8.8        | 13.2  | 4.4                         | 0     | 4.4        | 47.3  | 8.8                      | 56.1  | 37.4               | 1.76  | 1.40      | 3.16  |           |       |
| 4,000.....                   | 14.3                             | 8.8   | 13.2       | 4.4   | 28.6                         | 28.6  | 8.8        | 13.2  | 4.4                         | 0     | 4.4        | 51.7  | 17.6                     | 69.3  | 46.2               | 2.17  | 1.73      | 3.90  |           |       |
| 5,000.....                   | 14.3                             | 8.8   | 13.2       | 4.4   | 28.6                         | 28.6  | 8.8        | 13.2  | 4.4                         | 0     | 4.4        | 56.1  | 26.4                     | 82.5  | 55.0               | 2.59  | 2.05      | 4.64  |           |       |
| 6,000.....                   | 14.3                             | 8.8   | 13.2       | 4.4   | 28.6                         | 28.6  | 8.8        | 13.2  | 4.4                         | 0     | 4.4        | 47.3  | 8.8                      | 56.1  | 37.4               | 1.76  | 1.40      | 3.16  |           |       |
| 7,000.....                   | 14.3                             | 8.8   | 13.2       | 4.4   | 28.6                         | 28.6  | 8.8        | 13.2  | 4.4                         | 0     | 4.4        | 51.7  | 17.6                     | 69.3  | 46.2               | 2.17  | 1.73      | 3.90  |           |       |
| 8,000.....                   | 14.3                             | 8.8   | 13.2       | 4.4   | 28.6                         | 28.6  | 8.8        | 13.2  | 4.4                         | 0     | 4.4        | 56.1  | 26.4                     | 82.5  | 55.0               | 2.59  | 2.05      | 4.64  |           |       |
| 9,000.....                   | 14.3                             | 8.8   | 13.2       | 4.4   | 28.6                         | 28.6  | 8.8        | 13.2  | 4.4                         | 0     | 4.4        | 47.3  | 8.8                      | 56.1  | 37.4               | 1.76  | 1.40      | 3.16  |           |       |

1/ 7,000 pounds of manure comprise the average truckload.

2/ All the wait time in this operation is charged to the loader operator helper.

3/ Machine-minutes for the crawler-tractor and scoop loader are the same as the total man-minutes required for scooping manure from yard floor and loading onto truck. The remainder of the machine-minutes are for the 4-wheel dump truck.

4/ Three-man crew consists of a loader operator who operates the loader, a loader operator helper who manually cleans the yard area under hay racks, water troughs, and in corners, and a truck driver who performs the same functions as the loader operator helper while his truck is being loaded and also drives the truck to the dump, dumps the manure, and returns to the cleaning area.

5/ Four-man crew consists of the loader operator, loader operator helper, and two truck drivers. The functions performed are the same as those described for the 3-man crew, except one of the truck drivers is driving a truck or is waiting to be loaded.

6/ Five-man crew consists of the loader operator, loader operator helper, and three truck drivers. The functions performed are the same as those described for the 3-man crew, except two of the truck drivers are driving their trucks or waiting to be loaded.





Table 8.--Labor requirements and costs for cleaning 7,000 pounds of manure from the cattle yards by the rear-wheel drive tractor and scoop and four-wheel dump truck method, by crew sizes and transport distances 1/

|                    | Labor requirements by operations |                  |                   |                  |                  |                  |                         |                  |                  |                  | Equipment:            |                     | Labor and equipment |                  |
|--------------------|----------------------------------|------------------|-------------------|------------------|------------------|------------------|-------------------------|------------------|------------------|------------------|-----------------------|---------------------|---------------------|------------------|
|                    | Scooping manure                  |                  |                   |                  |                  | Transporting     |                         |                  |                  |                  | : require-<br>: ments | : 3/<br>: Machine-- | : Dollars           | : Dollars        |
|                    | from yard floor                  | yard floor       | Manually cleaning | Transporting     | manure to dump   | Productive: Wait | Total: Productive: Wait | time             | time             | time             |                       |                     |                     |                  |
| Transport distance | time                             | time             | time              | time             | time             | time             | time                    | time             | time             | time             | time                  | minutes             | minutes             | minutes          |
|                    | Productive: Wait                 | Productive: Wait | Productive: Wait  | Productive: Wait | Productive: Wait | Productive: Wait | Productive: Wait        | Productive: Wait | Productive: Wait | Productive: Wait | Productive: Wait      | Productive: Wait    | Productive: Wait    | Productive: Wait |
| Feet               | time                             | time             | time              | time             | time             | time             | time                    | time             | time             | time             | time                  | minutes             | minutes             | minutes          |
| 3-man crew         | time                             | time             | time              | time             | time             | time             | time                    | time             | time             | time             | time                  | minutes             | minutes             | minutes          |
| using 1            | time                             | time             | time              | time             | time             | time             | time                    | time             | time             | time             | time                  | minutes             | minutes             | minutes          |
| truck 4/           | time                             | time             | time              | time             | time             | time             | time                    | time             | time             | time             | time                  | minutes             | minutes             | minutes          |
| 1,000.....         | 9.9                              | 4.4              | 14.3              | 19.8             | 4.4              | 24.2             | 4.4                     | 0                | 4.4              | 34.1             | 8.8                   | 42.9                | 28.6                | 1.35             |
| 2,000.....         | 9.9                              | 8.8              | 18.7              | 19.8             | 8.8              | 28.6             | 8.8                     | 0                | 8.8              | 38.5             | 17.6                  | 56.1                | 37.4                | 1.76             |
| 3,000.....         | 9.9                              | 13.2             | 23.1              | 19.8             | 13.2             | 33.0             | 13.2                    | 0                | 13.2             | 42.9             | 26.4                  | 69.3                | 46.2                | 2.17             |
| 4-man crew         | time                             | time             | time              | time             | time             | time             | time                    | time             | time             | time             | time                  | minutes             | minutes             | minutes          |
| using 2            | time                             | time             | time              | time             | time             | time             | time                    | time             | time             | time             | time                  | minutes             | minutes             | minutes          |
| trucks 5/          | time                             | time             | time              | time             | time             | time             | time                    | time             | time             | time             | time                  | minutes             | minutes             | minutes          |
| 1,000.....         | 9.9                              | 0                | 9.9               | 19.8             | 0                | 19.8             | 4.4                     | 5.5              | 9.9              | 34.1             | 5.5                   | 39.6                | 29.7                | 1.25             |
| 2,000.....         | 9.9                              | 0                | 9.9               | 19.8             | 0                | 19.8             | 8.8                     | 1.1              | 9.9              | 38.5             | 1.1                   | 39.6                | 29.7                | 1.25             |
| 3,000.....         | 9.9                              | 3.3              | 13.2              | 19.8             | 3.3              | 23.1             | 13.2                    | 0                | 13.2             | 42.9             | 6.6                   | 49.5                | 36.3                | 1.55             |
| 4,000.....         | 9.9                              | 7.7              | 17.6              | 19.8             | 7.7              | 27.5             | 17.6                    | 0                | 17.6             | 47.3             | 15.4                  | 62.7                | 45.1                | 1.96             |
| 5,000.....         | 9.9                              | 12.1             | 22.0              | 19.8             | 12.1             | 31.9             | 22.0                    | 0                | 22.0             | 51.7             | 24.2                  | 75.9                | 53.9                | 2.38             |
| 6,000.....         | 9.9                              | 16.5             | 26.4              | 19.8             | 16.5             | 36.3             | 26.4                    | 0                | 26.4             | 56.1             | 33.0                  | 89.1                | 62.7                | 2.79             |
| 5-man crew         | time                             | time             | time              | time             | time             | time             | time                    | time             | time             | time             | time                  | minutes             | minutes             | minutes          |
| using 3            | time                             | time             | time              | time             | time             | time             | time                    | time             | time             | time             | time                  | minutes             | minutes             | minutes          |
| trucks 6/          | time                             | time             | time              | time             | time             | time             | time                    | time             | time             | time             | time                  | minutes             | minutes             | minutes          |
| 3,000.....         | 9.9                              | 0                | 9.9               | 19.8             | 0                | 19.8             | 13.2                    | 6.6              | 19.8             | 42.9             | 6.6                   | 49.5                | 39.6                | 1.55             |
| 4,000.....         | 9.9                              | 0                | 9.9               | 19.8             | 0                | 19.8             | 17.6                    | 2.2              | 19.8             | 47.3             | 2.2                   | 49.5                | 39.6                | 1.55             |
| 5,000.....         | 9.9                              | 1.1              | 11.0              | 19.8             | 1.1              | 20.9             | 22.0                    | 0                | 22.0             | 51.7             | 2.2                   | 53.9                | 42.9                | 1.68             |
| 6,000.....         | 9.9                              | 3.3              | 13.2              | 19.8             | 3.3              | 23.1             | 26.4                    | 0                | 26.4             | 56.1             | 6.6                   | 62.7                | 49.5                | 1.95             |
| 7,000.....         | 9.9                              | 5.5              | 15.4              | 19.8             | 5.5              | 25.3             | 30.8                    | 0                | 30.8             | 60.5             | 11.0                  | 71.5                | 56.1                | 2.23             |
| 8,000.....         | 9.9                              | 7.7              | 17.6              | 19.8             | 7.7              | 27.5             | 35.2                    | 0                | 35.2             | 64.9             | 15.4                  | 80.3                | 62.7                | 2.51             |
| 9,000.....         | 9.9                              | 9.9              | 19.8              | 19.8             | 9.9              | 29.7             | 39.6                    | 0                | 39.6             | 69.3             | 19.8                  | 89.1                | 69.3                | 2.78             |

1/ 7,000 pounds of manure comprise the average truckload.

2/ All the wait time in this operation is charged to the loader operator helper.

3/ Machine-minutes for the rear-wheel drive tractor and scoop loader are the same as the total man-minutes required for scooping manure from yard floor and loading onto truck. The remainder of the machine-minutes are for the four-wheel dump truck.

4/ Three-man crew consists of a loader operator who operates the loader, a loader operator helper who manually cleans the yard area under hay racks, water troughs, and in corners, and a truck driver who performs the same functions as the loader operator helper while his truck is being loaded and also drives the truck to the dump, dumps the manure, and returns to the cleaning area.

5/ Four-man crew consists of the loader operator, loader operator helper, and two truck drivers. The functions performed are the same as those described for the 3-man crew, except one of the truck drivers is driving a truck or is waiting to be loaded.

6/ Five-man crew consists of the loader operator, loader operator helper, and three truck drivers. The functions performed are the same as those described for the 3-man crew, except two of the truck drivers are driving their trucks or waiting to be loaded.

Table 9.---Labor requirements and costs for cleaning 7,000 pounds of manure from the cattle yards by the rear-wheel drive tractor and scoop and three-wheel dump truck method, by crew sizes and transport distances 1/

| Transport distance           | Labor requirements by operations |      |                              |      |                             |      |                       |      |                       |      | Equipment |         |    | Labor and equipment cost |                 |                 |
|------------------------------|----------------------------------|------|------------------------------|------|-----------------------------|------|-----------------------|------|-----------------------|------|-----------|---------|----|--------------------------|-----------------|-----------------|
|                              | Scooping manure from yard floor  |      | Manually cleaning yard floor |      | Transporting manure to dump |      | Total                 |      |                       |      | require-  |         | 3/ | Labor                    |                 | Equipment       |
|                              | Productive:Wait: time            | time | Productive:Wait: time        | time | Productive:Wait: time       | time | Productive:Wait: time | time | Productive:Wait: time | time | minutes   | minutes |    | Equipment: cost          | Equipment: cost | Equipment: cost |
| Feet                         |                                  |      |                              |      |                             |      |                       |      |                       |      |           |         |    |                          |                 |                 |
| 3-man crew using 1 truck 4/  |                                  |      |                              |      |                             |      |                       |      |                       |      |           |         |    |                          |                 |                 |
| 1,000.....                   | 9.9                              | 3.4  | 13.3                         | 19.8 | 3.4                         | 23.2 | 3.4                   | 0    | 3.4                   | 6.8  | 39.9      | 26.6    |    | 1.25                     | 0.56            | 1.81            |
| 2,000.....                   | 9.9                              | 6.8  | 16.7                         | 19.8 | 6.8                         | 26.6 | 6.8                   | 0    | 6.8                   | 13.6 | 50.1      | 33.4    |    | 1.57                     | .71             | 2.28            |
| 3,000.....                   | 9.9                              | 10.2 | 20.1                         | 19.8 | 10.2                        | 30.0 | 10.2                  | 0    | 10.2                  | 20.4 | 60.3      | 40.2    |    | 1.89                     | .85             | 2.74            |
| 4-man crew using 2 trucks 5/ |                                  |      |                              |      |                             |      |                       |      |                       |      |           |         |    |                          |                 |                 |
| 1,000.....                   | 9.9                              | 0    | 9.9                          | 19.8 | 0                           | 19.8 | 3.4                   | 6.5  | 9.9                   | 6.5  | 39.6      | 29.7    |    | 1.24                     | .55             | 1.79            |
| 2,000.....                   | 9.9                              | 0    | 9.9                          | 19.8 | 0                           | 19.8 | 6.8                   | 3.1  | 9.9                   | 3.1  | 39.6      | 29.7    |    | 1.24                     | .55             | 1.79            |
| 3,000.....                   | 9.9                              | 0.3  | 10.2                         | 19.8 | 0.3                         | 20.1 | 10.2                  | 0    | 10.2                  | 0.6  | 40.5      | 30.3    |    | 1.27                     | .57             | 1.84            |
| 4,000.....                   | 9.9                              | 3.7  | 13.6                         | 19.8 | 3.7                         | 23.5 | 13.6                  | 0    | 13.6                  | 7.4  | 50.7      | 37.1    |    | 1.59                     | .75             | 2.34            |
| 5,000.....                   | 9.9                              | 7.1  | 17.0                         | 19.8 | 7.1                         | 26.9 | 17.0                  | 0    | 17.0                  | 14.2 | 60.9      | 43.9    |    | 1.91                     | .96             | 2.87            |
| 6,000.....                   | 9.9                              | 10.5 | 20.4                         | 19.8 | 10.5                        | 30.3 | 20.4                  | 0    | 20.4                  | 21.0 | 71.1      | 50.7    |    | 2.23                     | 1.13            | 3.36            |
| 5-man crew using 3 trucks 6/ |                                  |      |                              |      |                             |      |                       |      |                       |      |           |         |    |                          |                 |                 |
| 3,000.....                   | 9.9                              | 0    | 9.9                          | 19.8 | 0                           | 19.8 | 10.2                  | 9.6  | 19.8                  | 9.6  | 49.5      | 39.6    |    | 1.55                     | .67             | 2.22            |
| 4,000.....                   | 9.9                              | 0    | 9.9                          | 19.8 | 0                           | 19.8 | 13.6                  | 6.2  | 19.8                  | 6.2  | 49.5      | 39.6    |    | 1.55                     | .67             | 2.22            |
| 5,000.....                   | 9.9                              | 0    | 9.9                          | 19.8 | 0                           | 19.8 | 17.0                  | 2.8  | 19.8                  | 2.8  | 49.5      | 39.6    |    | 1.55                     | .67             | 2.22            |
| 6,000.....                   | 9.9                              | 0.3  | 10.2                         | 19.8 | 0.3                         | 20.1 | 20.4                  | 0    | 20.4                  | 0.6  | 50.7      | 40.5    |    | 1.58                     | .69             | 2.27            |
| 7,000.....                   | 9.9                              | 2.0  | 11.9                         | 19.8 | 2.0                         | 21.8 | 23.8                  | 0    | 23.8                  | 4.0  | 57.5      | 45.6    |    | 1.79                     | .81             | 2.60            |
| 8,000.....                   | 9.9                              | 3.7  | 13.6                         | 19.8 | 3.7                         | 23.5 | 27.2                  | 0    | 27.2                  | 7.4  | 64.3      | 50.7    |    | 2.01                     | .93             | 2.94            |
| 9,000.....                   | 9.9                              | 5.4  | 15.3                         | 19.8 | 5.4                         | 25.2 | 30.6                  | 0    | 30.6                  | 10.8 | 71.1      | 55.8    |    | 2.22                     | 1.04            | 3.26            |

1/ 7,000 pounds of manure comprise the average truckload.

2/ All the wait time in this operation is charged to the loader operator helper.

3/ Machine-minutes for the rear-wheel drive tractor and scoop are the same as the total man-minutes required for scooping manure from yard floor and loading onto truck. The remainder of the machine-minutes is for the 3-wheel dump truck.

4/ Three-man crew consists of a loader operator who operates the loader, a loader operator helper who manually cleans the yard area under hay racks, water troughs, and in corners, and a truck driver who performs the same functions as the loader operator helper while his truck is being loaded and also drives the truck to the dump, dumps the manure, and returns to the cleaning area.

5/ Four-man crew consists of the loader operator, loader operator helper, and two truck drivers. The functions performed are the same as those described for the 3-man crew, except one of the truck drivers is driving a truck or is waiting to be loaded.

6/ Five-man crew consists of the loader operator, loader operator helper, and three truck drivers. The functions performed are the same as those described for the 3-man crew, except two of the truck drivers are driving their trucks or waiting to be loaded.





Table 11.--Labor requirements and costs for cleaning 7,000 pounds of manure from the cattle yards by the front-wheel drive tractor and scoop and three-wheel dump truck method, by crew sizes and transport distances <sup>1/</sup>

| Transport distance           | Labor requirements by operations |       |      |       |      |                              |       |      |       |      | Equipment                   |       | Labor and equipment cost |       |
|------------------------------|----------------------------------|-------|------|-------|------|------------------------------|-------|------|-------|------|-----------------------------|-------|--------------------------|-------|
|                              | Scooping manure from yard floor  |       |      |       |      | Manually cleaning yard floor |       |      |       |      | Transporting manure to dump |       | Total                    |       |
|                              | Productive:Wait:Total            |       |      |       |      | Productive:Wait:Total        |       |      |       |      | Productive:Wait:Total       |       | Productive:Wait:Total    |       |
|                              | time                             | :time | time | :time | time | time                         | :time | time | :time | time | time                        | :time | time                     | :time |
| Feet                         |                                  |       |      |       |      |                              |       |      |       |      |                             |       |                          |       |
| 3-man crew                   |                                  |       |      |       |      |                              |       |      |       |      |                             |       |                          |       |
| using 1 truck <sup>4/</sup>  |                                  |       |      |       |      |                              |       |      |       |      |                             |       |                          |       |
| 1,000.....                   | 8.7                              | 3.4   | 12.1 | 17.4  | 3.4  | 20.8                         | 3.4   | 0    | 3.4   | 0    | 3.4                         | 29.5  | 6.8                      | 36.3  |
| 2,000.....                   | 8.7                              | 6.8   | 15.5 | 17.4  | 6.8  | 24.2                         | 6.8   | 0    | 6.8   | 0    | 6.8                         | 32.9  | 13.6                     | 46.5  |
| 3,000.....                   | 8.7                              | 10.2  | 18.9 | 17.4  | 10.2 | 27.6                         | 10.2  | 0    | 10.2  | 0    | 10.2                        | 36.3  | 20.4                     | 56.7  |
| 4-man crew                   |                                  |       |      |       |      |                              |       |      |       |      |                             |       |                          |       |
| using 2 trucks <sup>5/</sup> |                                  |       |      |       |      |                              |       |      |       |      |                             |       |                          |       |
| 1,000.....                   | 8.7                              | 0     | 8.7  | 17.4  | 0    | 17.4                         | 3.4   | 5.3  | 8.7   | 29.5 | 5.3                         | 34.8  | 26.1                     | 1.09  |
| 2,000.....                   | 8.7                              | 0     | 8.7  | 17.4  | 0    | 17.4                         | 6.8   | 1.9  | 8.7   | 32.9 | 1.9                         | 34.8  | 26.1                     | 1.09  |
| 3,000.....                   | 8.7                              | 1.5   | 10.2 | 17.4  | 1.5  | 18.9                         | 10.2  | 0    | 10.2  | 36.3 | 3.0                         | 39.3  | 29.1                     | 1.23  |
| 4,000.....                   | 8.7                              | 4.9   | 13.6 | 17.4  | 4.9  | 22.3                         | 13.6  | 0    | 13.6  | 39.7 | 9.8                         | 49.5  | 35.9                     | 1.55  |
| 5,000.....                   | 8.7                              | 8.3   | 17.0 | 17.4  | 8.3  | 25.7                         | 17.0  | 0    | 17.0  | 43.1 | 16.6                        | 59.7  | 42.7                     | 1.87  |
| 6,000.....                   | 8.7                              | 11.7  | 20.4 | 17.4  | 11.7 | 29.1                         | 20.4  | 0    | 20.4  | 46.5 | 23.4                        | 69.9  | 49.5                     | 2.19  |
| 5-man crew                   |                                  |       |      |       |      |                              |       |      |       |      |                             |       |                          |       |
| using 3 trucks <sup>6/</sup> |                                  |       |      |       |      |                              |       |      |       |      |                             |       |                          |       |
| 3,000.....                   | 8.7                              | 0     | 8.7  | 17.4  | 0    | 17.4                         | 10.2  | 7.2  | 17.4  | 36.3 | 7.2                         | 43.5  | 34.8                     | 1.36  |
| 4,000.....                   | 8.7                              | 0     | 8.7  | 17.4  | 0    | 17.4                         | 13.6  | 3.8  | 17.4  | 39.7 | 3.8                         | 43.5  | 34.8                     | 1.36  |
| 5,000.....                   | 8.7                              | 0     | 8.7  | 17.4  | 0    | 17.4                         | 17.0  | 0.4  | 17.4  | 43.1 | 0.4                         | 43.5  | 34.8                     | 1.36  |
| 6,000.....                   | 8.7                              | 1.5   | 10.2 | 17.4  | 1.5  | 18.9                         | 20.4  | 0    | 20.4  | 46.5 | 3.0                         | 49.5  | 39.3                     | 1.54  |
| 7,000.....                   | 8.7                              | 3.2   | 11.9 | 17.4  | 3.2  | 20.6                         | 23.8  | 0    | 23.8  | 49.9 | 6.4                         | 56.3  | 44.4                     | 1.76  |
| 8,000.....                   | 8.7                              | 4.9   | 13.6 | 17.4  | 4.9  | 22.3                         | 27.2  | 0    | 27.2  | 53.3 | 9.8                         | 63.1  | 49.5                     | 1.97  |
| 9,000.....                   | 8.7                              | 6.6   | 15.3 | 17.4  | 6.6  | 24.0                         | 30.6  | 0    | 30.6  | 56.7 | 13.2                        | 69.9  | 54.6                     | 2.18  |

<sup>1/</sup> 7,000 pounds of manure comprise the average truckload.

<sup>2/</sup> All the wait time in this operation is charged to the loader operator helper.

<sup>3/</sup> Machine-minutes for the front-wheel drive loader are the same as the total man-minutes required for scooping manure from yard floor and loading onto truck. The remainder of the machine-minutes is for the 3-wheel dump truck.

<sup>4/</sup> Three-man crew consists of a loader operator who operates the loader, a loader operator helper who manually cleans the yard area under hay racks, water troughs, and in corners, and a truck driver who performs the same functions as the loader operator helper while his truck is being loaded and also drives the truck to the dump, dumps the manure, and returns to the cleaning area.

<sup>5/</sup> Four-man crew consists of the loader operator, loader operator helper, and two truck drivers. The functions performed are the same as those described for the 3-man crew, except one of the truck drivers is driving a truck or is waiting to be loaded.

<sup>6/</sup> Five-man crew consists of the loader operator, loader operator helper, and three truck drivers. The functions performed are the same as those described for the 3-man crew, except two of the truck drivers are driving their trucks or waiting to be loaded.





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